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MEAN PERFORMANCE, COMBINING ABILITY AND HETEROSIS OF NEW EGYPTIAN COTTON GENOTYPES AS PARENTAL GENOTYPES IN BREEDING PROGRAMS

1 – YIELD AND YIELD COMPONENT CHARACTERS

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ABSTRACT

This study is concerned with the objective of obtaining guidelines on the potential use of new Egyptian cotton genotypes in breeding programs for developing superior cultivars. Nine new and old Egyptian genotypes were crossed in diallel pattern (without reciprocal). Their 36 F_1's and 36 F_2's hybrids were evaluated at two environments in the experimental farm of Faculty of Agric. El- Fayoum, Cairo University. The work was carried out during 1999, 2000 and 2001 summer seasons. The experimental design was the randomized complete block design. Information on combining ability, heterosis and inbreeding depression effects were estimated for yield and yield components. The obtained data, generally, revealed that the genotypes (as combiners) exhibited noticeable differences in their positive significant general combining ability regarding yield characters. These effects mostly differed in the two environments at which the genotypes were grown.

Data of specific combining ability effects, showed that most hybrid combinations out of a total of 36 ones proved to have positive effects on several studied characters. The Egyptian cotton genotypes Ashmouni, Dandara, Giza 45, Giza 70 and Giza 88 genotypes exhibited significant positive general combining ability effects with regard to seed cotton yield and most of its contributing variables. Confirmation for those results were also obvious from the data of heterosis and inbreeding depression effects. The parents which proved to have desirable GCA effects, do not necessarily produce hybrid of desirable SCA effects and vice versa. The tested genotypes differed markedly in their potentiality yet each variety still has its own high potentiality as combiners with respect to some specific character or characters.

Key words: ***Cotton cultivars, Combining ability, Heterosis, Inbreeding depression.***

INTRODUCTION

Both old and newly released Egyptian commercial cotton genotypes are used as parental types in different breeding programs. However, most of the old genotypes proved already to be good combiners as judged by their ability to transmit high yield and quality to their progenies in crosses and succeeded to develop new promising cotton genotypes. Nevertheless, as for the relatively new and newly released Egyptian genotypes, it seems important to investigate their potential performance when used as parental types from the standpoint of either general or specific combining ability, heterosis and inbreeding depression effects. Also, genotype x environment interactions for those new genotypes and their hybrid combinations were considered in this study. Accordingly, genotypes which would be capable of performing as good combiners on account of their impacts on different genetic parameters, should be adopted in the concerned breeding programs. El- Debaby *et al* (1997) found highly significant effects for general combining ability (GCA) and specific combining ability (SCA) for each of seed cotton yield per plant, lint yield per plant, number of bolls per plant, boll weight, lint percentage and seed and lint indices traits. Hassan and Awaad (1997) showed that, Giza 45, Giza 85 and Giza 80 and their F_1's crosses gave the highest mean values for number of open bolls per plant, consequently, these genotypes could be considered as good general combiners for those studied traits. Patel *et al* (1997) evaluated GCA and SCA effects on seed cotton yield trait and revealed that the ratio variances due to general and specific combining abilities indicated that SCA was of higher magnitude for the studied character. Further, the magnitude of non-additive effects on this trait was relatively high. Pavasia *et al* (1999) found that the components of variance for general and specific combining ability were highly significant as for seed and lint indices traits. At the meantime, the GCA effects showed greater magnitudes than SCA for the previously mentioned characters, indicating the preponderance of additive gene action. Abo El-Zahab and Amein (2000 a and 2000 b), El-Adl *et al* (2001) and Mosalem *et al* (2003) reported significant general and specific combining abilities for seed cotton yield per plant and its component characters. Gomma (1997) demonstrated highly significant and positive heterotic effects on seed cotton yield and number of bolls per plant. While, insignificant effect for boll weight trait was determined. This implies the large effect of non- additive genes. Abo-Arab *et al* (1997) showed that heterotic effects as estimated relative to mid parent value were significant and positive for seed cotton yield per plant, boll weight, lint yield per plant and seed index.

Khalil and Khattab (1997) concluded that heterotic effects and inbreeding depression were highly significant for number of open bolls per plant. Abdel–Gelil (2001) showed that heterotic effects relative to better–parents and inbreeding depression had significant and positive effects on seed cotton yield, lint yield per plant , boll weight , seed index and lint index traits.

El-Disouqi and Ziena (2001) found significant and negative heterosis for number of bolls per plant, and seed and lint cotton yields in two studied hybrids. Abdel–Zaher *et al* (2003) reported highly significant and negative heterotic effects as determined relative to both mid- and better parents for boll weight, seed index and lint index in the second studied intraspecific hybrid. Nawar and El-Sayed (1990) and Hendawy (1994) detected significant inbreeding depression values for seed cotton yield per plant, number of bolls and boll weight.

Therefore, the objectives of this study was: (1) to evaluate nine parental genotypes regarding their general and specific combining ability effects. (2) to investigate the magnitude of heterosis expression and inbreeding depression effects on yield and yield components in Egyptian cotton genotypes.

MATERAILS AND METHODS

The present study was carried out at the Experimental Farm of the Faculty of Agriculture, in El-Fayoum Cairo University, during the three successive summer growing seasons of 1999, 2000 and 2001 to study the potential use of new Egyptian cotton cultivars as parental genotypes in breeding programs. Plants grown from selfed seeds of nine different genotypes comprising old genotypes as well as newly released cultivars (*Gossypium barbadenes* L.) were crossed by hand in a diallel mating design, excluding reciprocals in 1999 season. Artificial self pollination was conducted for the resultant 36 F_1's to produce F_2's in 2000 season. In the same season, the same crosses were carried out again to produce new F_1 seeds in the next season. Thus, in 2000 season 45 entries comprising 9 parents and 36 F_1's crosses were available. In the following season of 2001, a total of 81 entries comprising 9 parents, 36 F_1's and F_2's were grown on two planting dates, *i.e.*, 5th March and 7th April. Those two planting dates have been regarded as two different environments (E_1 and E_2). Each experiment was laid out in a complete randomized block design, with three replications. Plot size was represented by one row, of 0.60 m. width x 4 m. length. (each row contains 17 plants using a hills spacing of 25 cm). Ten individual randomly guarded plants were monitored and tagged to obtain required data. The used parents were Ashmouni (P_1), Dandara (P_2), Giza 85 (P_3), Giza 80 (P_4), Giza 83 (P_5), Giza 86 (P_6), Giza 88 (P_7), Giza 70 (P_8) and Giza 45 (P_9). Pure seeds of the nine genotypes were obtained from Cotton Breeding Section, Cotton Research Institute, Agricultural Research Center (ARC). Recommended agricultural practices for cotton production were applied at the proper time in Fayoum region. The studied characters were: Seed cotton yield per plant (S.C.Y/P.), Lint yield per plant (L.Y./P.), Number of bolls per plant (No.B./P.), Boll weight (B.W.), Seed index (S.I.) and Lint index (L.I.). Estimates of both general combining ability (GCA) and specific combining ability (SCA) were computed according to Griffing (1956) designated as method 2 model 1 where parents and one set of F_1's were included without reciprocals *i.e.*, [P + (P+1)]/2 combinations. Forms of analysis for individual environments was given by Griffing (1956) and Singh and Chaudhary (1979). The combined analysis was made over the two different environments to test the interactions of the different genetic components with the two environments as shown by Singh (1973). General combining ability (GCA) and specific combining ability (SCA) for each individual environment as well as the analysis of the combined over environments were calculated; using basic program prepared by Central Laboratory for Designing and Statistical Analysis, ARC, according to Griffing's method 2 model 1. Further, heterosis, heterobeltiosis and inbreeding depression effects were also calculated at the pervious Central Lab.

RESULTS AND DISCUSSION

1- Analysis of variance

The analysis of variance (Table 1) showed significance variation due to environments (E), parents (P), genotypes (G) viz, parents and their hybrid combinations and genotype x environment (G x E) interaction for cotton yield and its component characters. The significant variation of genotypes indicated that the data are reliable for further analysis by diallel mating procedure as suggested by Griffing (1956).

The mean square values of general and specific combining ability effects on yield and its contributing variables were highly significant in the two environments and their combined data in both F_1 and F_2 generations (Table 1). The relative magnitude of additive to non-additive effects for the combined data expressed as GCA/SCA ratio, exceeded unity for some traits. In case of seed cotton yield per plant, lint yield per plant, boll weight and number of bolls traits showed ratios less than unity of GCA/SCA, showing the prevalence of non-additive gene action in the genetics of these characters and could be improved through hybrid breeding program.

Table 1. Mean squares of individual and combined data for genotypes (G), general combining ability (GCA), specific combining ability (SCA), GCA/SCA ratios and RI for yield and yield components calculated in F_1 and F_2 generations.

Source of variance	Seed cotton yield (g) / plant						Lint yield (g) / plant					
	F_1			F_2			F_1			F_2		
	E_1	E_2	Comb.	E_1	E_2	Comb.	E_1	E_2	Comb.	E_1	E_2	Comb.
Rep./E	63.65**	11.66	37.66**	1.03	3.89	2.46	9.74**	3.53*	6.64**	0.406	0.15	0.28
Environments (E)			483.28**			148.53**			89.84**			22.04**
Parents (P)			31.56**			31.56**			3.72**			3.72**
PXE			30.61**			30.61**			3.62**			3.62**
Genotypes (G)	25.16**	36.66**	41.29**	43.28**	63.14**	97.46**	4.00**	4.52**	5.58**	6.48**	6.90**	12.13**
GXE			20.53**			8.96**			2.95**			1.25**
GCA	42.48**	29.12**	25.87**	47.21**	50.40**	54.84**	8.31**	3.52**	4.13**	5.21**	5.65**	5.42**
SCA	21.31**	38.34**	27.90**	42.41	65.97**	67.22**	3.05**	4.75**	3.63**	6.76**	7.18**	8.68**
GCAXE			45.73**			42.77**			7.70**			5.45**
SCAXE			31.75**			41.16**			4.16**			5.25**
Pooled error	8.53	5.32	6.92	5.83	4.60	5.22	1.26	0.73	0.99	0.75	0.61	0.68
GCA/SCA	1.99	0.76	0.93	1.11	0.76	0.82	2.73	0.74	1.14	0.77	0.79	0.62
RI	0.65	0.53	0.50	0.61	0.67	0.61	0.71	0.49	0.54	0.53	0.65	0.54
Correlation coefficient (r)	0.56	0.87**	0.67*	0.91**	0.90**	0.95**	0.71*	0.63	0.67*	0.85**	0.95**	0.91**

*, ** Significance at 5% and 1% levels, respectively.

Table 1. Cont.

Source of variance	Number of bolls / plant						Boll weight (g)					
	F_1			F_2			F_1			F_2		
	E_1	E_2	Comb.	E_1	E_2	Comb.	E_1	E_2	Comb.	E_1	E_2	Comb.
Rep./E	1.43	0.10	0.76	1.86*	0.41	1.13	0.01*	0.04*	0.02**	0.01	0.05**	0.03**
Environments (E)			57.87**			9.78**			0.77**			0.66**
Parents (P)			8.15**			8.15**			0.05**			0.05**
PXE			9.86**			9.86**			0.05**			0.05**
Genotypes (G)	11.88**	13.41**	16.97**	11.07**	11.75**	16.18**	0.07**	0.09**	0.11**	0.10**	0.08**	0.14**
GXE			8.32**			6.65**			0.04**			0.03**
GCA	15.31**	6.34**	8.80**	10.73**	18.62**	14.30**	0.08**	0.11**	0.09**	0.14**	0.04**	0.09**
SCA	11.12**	14.98**	11.87**	11.15**	10.23**	10.00**	0.07**	0.08**	0.07**	0.09**	0.08**	0.09**
GCAXE			12.86**			15.05**			0.10**			0.09**
SCAXE			14.22**			11.37**			0.08**			0.08**
Pooled error	1.20	0.82	1.01	0.67	1.12	0.89	0.001	0.008	0.005	0.006	0.003	0.004
GCA/SCA	1.38	0.42	0.74	0.96	1.82	1.43	1.19	1.38	1.32	1.63	0.52	0.97
RI	0.54	0.39	0.46	0.46	0.73	0.64	0.56	0.56	0.57	0.74	0.71	0.79
Correlation coefficient (r)	0.70*	0.49	0.50	0.63	0.90**	0.76*	0.32	0.62	0.54	0.85**	0.78**	0.61

Table 1. Cont.

Source of variance	Seed index (g)						Lint index (g)					
	F_1			F_2			F_1			F_2		
	E_1	E_2	Comb.	E_1	E_2	Comb.	E_1	E_2	Comb.	E_1	E_2	Comb.
Rep./E	0.18	0.02	0.10	0.10	1.16**	0.53**	0.13	0.30	0.22	0.08	0.54**	0.31**
Environments (E)			0.41*			0.01			2.59**			0.09
Parents (P)			1.32**			1.32*			0.48**			0.48**
PXE			0.20			0.20*			0.26**			0.26**
Genotypes (G)	0.63**	0.54**	0.92**	0.56**	0.52**	0.98**	0.61**	0.29**	0.53**	0.46**	0.18	0.42**
GXE			0.25**			4.41**			0.37**			0.22**
GCA	2.15**	1.02**	1.80**	2.08**	1.16**	2.03**	1.22**	0.43**	0.78**	0.98**	0.22**	0.56**
SCA	0.29**	0.43**	0.35**	0.22**	0.38**	0.35**	0.47**	0.25**	0.26**	0.35**	0.17*	0.22**
GCAXE			1.37**			1.21**			0.87**			0.63**
SCAXE			0.37**			0.25**			0.47**			0.30**
Pooled error	0.10	0.19	0.14	0.08	0.10	0.09	0.09	0.10	0.10	0.07	0.09	0.08
GCA/SCA	7.35	2.38	5.17	9.66	3.05	5.87	2.58	1.70	3.06	2.81	1.28	2.55
RI	0.87	0.71	0.83	0.92	0.82	0.90	0.70	0.59	0.72	0.75	0.57	0.74
Correlation coefficient (r)	0.89**	0.62	0.80**	0.87**	0.60	0.75*	0.63	0.66	0.81**	0.90**	0.54	0.79*

Generally, the magnitude of GCA mean squares were greater than SCA mean squares, indicating that the magnitude of additive and additive x additive genetic effects were considerable in the inheritance of such characters than non-additive effect. On the other hand, low GCA/SCA ratios which showed values less than the unity in some cases indicate predominance of non- additive gene action. Baker (1978) suggested that the relative importance (RI) of general and specific combining ability in determining progeny performance should be assessed by estimating the components of variance and expressing them as the ratio of 2 $\delta^2_g / 2\delta^2_g + \delta^2_s$, where δ^2_g = GCA component of variance and δ^2_s = SCA component of variance (Gravios 1994). The relative importance of additive and non-additive effects was assessed by the ratio of variance of fixed effect (Baker 1978). Correlation coefficients between GCA effects and parental means were strongly positive for the combined analysis over two environments in most studied traits (Table 2). These findings indicate that the mean performance values of any parental variety give a good indication of intrinsic performance of its GCA effects, therefore selection among the tested parental genotypes for initiating any proposed breeding program could be practiced either on mean performance values or GCA effects basis with similar efficiency. Thus the breeding value of genotype may be determined by its phenotypic performance.

2- Mean performance

The mean performance values of hybrids *i.e.* P_3 x P_5 and P_3 x P_7 showed higher values than their parents in combined data, which are ascribed to their specific combining ability and heterotic effects (Tables 3 and 4). Similar results were obtained by Abo-Arab *et al.* (1997), Khalil, and Khattab (1997) and Abo El-Zahab and Amein (2000 a).

Giza 45 (P_9) exhibited lighter boll weight, meanwhile P_2 and P_6 showed heavier boll weight. In F_1 generation no obvious trend could detected towards the inheritance of this trait. Regarding lit yield character, the genotypes Giza 70 and Giza 45 showed higher mean values among the tested genotypes and were able to transmit their superiority to most of their hybrids. The obtained mean values of seed index character, indicated that the variety Dandara (P_2) showed highest mean values in the combined data over the two environments.

Table 2. General combining ability (GCA) effects for yield and yield component traits in parental cotton genotypes calculated in F_1 and F_2 generations (combined data of two environments).

Parents	Seed cotton yield (g) /plant		Lint yield (g)/ plant		Number of bolls /plant		Boll weight (g)		Seed index (g)		Lint index (g)	
	F_1	F_2	F_1	F_2	F_1	F_2	F_1	F_2	F_1	F_2	F_1	F_2
P1	0.558*	0.521**	0.193*	0.163*	-0.163*	0.350**	0.024**	0.016**	0.389**	0.515**	0.202**	0.267**
P2	-0.606**	0.198	-0.146	-0.134*	-0.789	-0.303**	0.099**	0.096**	0.251**	0.161**	0.180**	-0.057*
P3	-0.577**	-2.351**	-0.267**	-0.840**	-0.077**	-0.715**	-0.015**	0.010**	0.078*	-0.085**	0.005	-0.024*
P4	-0.555*	0.876**	-0.143	0.332**	-0.283*	-0.042	-0.022**	-0.021**	-0.078*	-0.050*	-0.018	-0.022*
P5	-1.032**	-0.661**	-0.538**	-0.151*	-0.062*	0.041	-0.049**	0.004**	-0.084*	-0.155**	-0.162**	-0.024*
P6	0.302	-0.799**	0.067	-0.130	0.377**	0.924**	0.023**	-0.001*	-0.125**	-0.085**	0.044	0.052*
P7	0.738**	1.364**	0.062	0.286**	-0.029	0.247**	0.014**	0.010**	-0.111**	-0.049*	-0.173**	-0.144**
P8	1.115**	0.610**	0.431**	0.264**	0.821**	0.829**	-0.042**	0.060**	-0.246**	-0.167**	-0.090**	-0.045*
P9	0.663**	0.242	0.342**	0.153*	0.205*	0.518**	0.033**	0.053**	-0.076*	-0.086**	0.019	-0.002
LSD 5%(Gi)	0.423	0.367	0.160	0.132	0.162	0.152	0.001	0.001	0.061	0.005	0.050	0.005
LSD 1%(Gi)	0.570	0.495	0.216	0.178	0.218	0.205	0.002	0.002	0.082	0.066	0.068	0.062

*, ** Significance at 5% and 1% levels, respectively.

Table 3. Estimates of specific combining ability (SCA) effects for yield and yield component traits of 36 cotton crosses in F_1 and F_2 generations across combined data of two environments.

Crosses	Seed cotton yield (g) / plant		Lint yield (g)/ plant		Number of bolls /plant		Boll weight (g)		Seed index (g)		Lint index (g)	
	F_1	F_2	F_1	F_2	F_1	F_2	F_1	F_2	F_1	F_2	F_1	F_2
P1 x P2	1.640*	3.839**	0.724**	1.019**	-0.055	-1.007**	-0.125**	0.038**	-0.224*	-0.076	-0.017	-0.231**
P1 x P3	-0.893	-0.412	-0.286	-0.051	-0.134	0.905**	0.058**	-0.130**	-0.001	0.253**	0.002	0.187*
P1 x P4	1.755*	-3.266**	0.193	-1.316**	0.739**	-1.368**	0.120*	-0.037**	0.288**	0.485**	-0.105	0.099
P1 x P5	3.082**	-2.689**	0.866**	-0.827*	-1.316**	-0.401	0.224**	-0.052**	0.344**	0.006	0.052	0.085
P1 x P6	-0.632	1.618**	0.133	0.531*	-2.289**	0.014	0.193**	-0.018**	0.569**	0.220**	0.563**	0.095
P1 x P7	-2.908**	2.609**	-0.853**	0.469*	-0.349	1.276**	-0.144**	-0.103**	0.105	0.450**	0.146	-0.076
P1 x P8	-4.032**	-4.350**	-1.784**	-1.080**	-1.349**	-0.305	0.015*	0.011**	-0.394**	-0.465**	-0.426**	0.087
P1 x P9	-0.986	-7.470**	-0.226	-2.676**	-0.349	-2.195**	0.125**	0.057**	-0.330**	-0.445**	-0.178*	-0.306**
P2 x P3	-1.536*	-4.649**	-0.690	-1.366**	-0.142	-1.409**	0.015*	-0.007**	-0.047	-0.226**	-0.149	0.061
P2 x P4	-0.418	-2.439**	0.125	-0.798**	-0.536*	-1.648**	0.102**	-0.079**	0.176	-0.177*	0.310**	-0.062
P2 x P5	-1.758*	-4.866**	-0.361	-1.657**	-0.557*	-0.165	-0.066**	0.021**	-0.151	-0.356**	0.080	-0.178*
P2 x P6	-2.098**	-2.008**	-0.982**	-0.852**	-1.930**	-0.566*	0.169**	-0.021**	-0.161	-0.209*	-0.265**	-0.233**
P2 x P7	0.129	-0.337	0.396	0.699**	1.410**	1.196**	0.104**	0.013**	0.126	-0.162*	0.319**	0.473**
P2 x P8	-0.158	-3.154**	0.682*	-1.450**	-1.774**	1.281**	0.268**	-0.159**	-0.156	-0.127	0.445**	-0.351**
P2 x P9	-1.866**	3.752**	-0.374	1.393**	-0.024	0.625*	-0.046*	-0.065**	-0.492**	-0.391**	-0.069	-0.132
P3 x P4	-0.860	1.677**	-0.147	0.663**	-1.848**	-0.003	0.051**	-0.006**	-0.235**	-0.182*	-0.018	-0.021
P3 x P5	3.113**	-0.987	1.531**	-0.148	1.098**	0.048	0.087**	-0.072**	0.472**	-0.094	0.530**	0.104
P3 x P6	-0.784	-3.329**	-0.537*	-1.351**	2.558**	-1.921**	-0.112**	-0.095**	-0.321**	-0.180*	-0.348**	-0.213**
P3 x P7	4.567**	-1.975**	1.054**	-1.143**	2.431**	1.225**	-0.101**	-0.123**	0.266**	0.050	-0.164*	-0.357**

Table 3.Cont.

P3 x P8	1.126	-0.828	0.169	-0.708**	-1.386**	0.743**	-0.152**	-0.013**	0.034	0.152	-0.112	-0.229**
P3 x P9	-2.418**	-1.176	-0.807**	-0.230	-1.669**	-1.263**	0.238**	-0.039**	0.614**	-0.079	0.373**	0.108
P4 x P5	-2.540**	2.636**	-0.953**	0.905**	-0.663*	-0.259	0.011*	0.140**	-0.039	0.021	-0.085	-0.007
P4 x P6	-3.232**	-0.193	-1.424**	0.165	-1.602**	-0.093	-0.002	-0.049**	0.202*	-0.199*	-0.079	0.079
P4 x P7	-3.988**	-3.885**	-1.443**	-1.624**	-1.763**	-3.465**	-0.006*	-0.116**	-0.212*	-0.135	-0.164*	-0.265**
P4 x P8	-1.539*	-0.442	-0.685**	-0.442	0.354	1.287**	-0.007*	-0.139**	0.023	0.084	-0.098	-0.137
P4 x P9	1.513*	-4.673**	0.630**	-1.934**	-0.430	0.731**	-0.026*	-0.136**	-0.114	-0.131	0.013	-0.287**
P5 x P6	0.949	-3.620**	-0.003	-1.547**	1.376**	-1.610**	-0.076**	-0.141**	-0.092	0.073	-0.247**	-0.188*
P5 x P7	-3.732**	-1.586*	-1.490**	-0.463*	-2.684**	-1.215**	-0.118**	-0.155**	0.161	-0.097	-0.082	-0.012
P5 x P8	-1.350	-0.822	-0.780**	-0.137	1.466**	-0.496*	-0.074**	-0.070**	-0.054	-0.029	-0.248**	0.072
P5 x P9	-3.667**	0.617	-1.295**	0.357	-2.218**	0.981**	0.019*	-0.120**	-0.307**	0.091	-0.173*	0.145
P6 x P7	-1.175	-4.181**	-0.140	-1.225**	-1.090**	-0.583*	-0.065**	-0.107**	-0.132	-0.100	0.093	0.120
P6 x P8	1.697*	-2.101**	0.967**	-0.839**	0.426	-1.065**	0.097**	-0.131**	0.020	0.068	0.223**	-0.028
P6 x P9	2.026**	1.678**	0.407	0.176	1.476**	-0.487	-0.078**	-0.077**	-0.283**	-0.146	-0.323**	-0.345**
P7 x P8	-2.349**	-0.867	-0.424	0.185	-2.101**	-3.469**	0.119**	-0.071**	-0.044	-0.002	0.208**	0.318**
P7 x P9	2.407**	-1.338**	0.975**	-0.508*	-1.018**	0.942**	0.146**	-0.089**	-0.213*	-0.132	-0.039	-0.105
P8 x P9	0.946	-2.018**	0.081	-0.525*	1.466**	-0.874**	-0.083**	0.015**	0.255*	-0.114	-0.022	0.061
LSD 5%(S_{ij})	1.361	1.182	0.516	0.426	0.520	0.489	0.004	0.004	0.196	0.157	0.162	0.147
LSD 1%(S_{ij})	1.834	1.592	0.695	0.574	0.700	0.659	0.050	0.005	0.264	0.212	0.218	0.198

* ,** Significance at 5% and 1% levels, respectively.

Table 4. Estimates of heterosis (M.P.), heterobeltiosis (B.P.) and inbreeding depression (I.D.) for yield and its contributing variables (combined data of two environments).

Crosses	Seed cotton yield (g) / plant			Lint yield (g) / plant			Number of bolls / plant		
	M.P.	B.P.	I.D.	M.P.	B.P.	I.D.	M.P.	B.P.	I.D.
P1 x P2	-1.88	-2.93	1.38	2.42**	-1.83*	8.14**	-15.19**	-20.59**	-0.24
P1 x P3	-3.21	-9.85**	14.76**	-4.36**	-10.75**	14.13**	-8.28**	-16.56**	-6.87**
P1 x P4	-3.99	-5.21*	19.82**	-8.03**	-9.98**	19.74**	-12.54**	-12.78**	9.94**
P1 x P5	2.37	-0.12	24.59**	-0.52**	-3.79**	21.54**	-22.51**	-23.99**	-12.69**
P1 x P6	-6.25**	-8.36**	5.21**	-4.51**	-4.81**	9.27**	-25.16**	-27.39**	-13.16**
P1 x P7	-14.63**	-17.28**	-8.30**	-12.91**	-13.19**	-2.08**	-18.4**	-19.17**	-18.52**
P1 x P8	-16.63**	-19.23**	13.82**	-19.39**	-21.59**	7.41**	-20.76**	-22.84**	-12.17**
P1 x P9	-6.29**	-6.68**	30.77**	-5.42**	-5.47**	33.03**	-14.96**	-16.14**	7.85**
P2 x P3	-7.51**	-12.98**	24.45**	-6.47**	-9.04**	23.39**	-6.15**	-9.00**	[illegible]
P2 x P4	-11.89**	-13.93**	10.12**	-7.41**	-13.06**	14.19**	-19.50**	-24.82**	3.41**
P2 x P5	-13.69**	-14.89**	17.87**	-9.39**	-10.21**	20.54**	-16.20**	-20.09**	-7.99**
P2 x P6	[illegible]	-13.79**	10.00**	-12.35**	-15.74**	12.61**	-21.78**	-24.61**	-4.80**
P2 x P7	-8.98**	-12.73**	7.04**	-1.69*	-6.07**	6.25**	-5.28**	-12.08**	-3.80**
P2 x P8	-8.43**	-12.21**	18.14**	0.99	-5.73**	28.30**	-22.47**	-29.18**	-30.06**
P2 x P9	-11.06**	-11.58**	-8.04**	-5.32**	-9.21**	-2.61**	-11.16**	-15.72**	-11.15**
P3 x P4	-7.71**	-15.04**	3.99*	-8.21**	-16.03**	4.72**	-21.35**	-28.62**	-12.69**
P3 x P5	6.75**	1.79	25.56**	8.65**	4.72**	25.02**	3.22**	-4.42**	11.09**
P3 x P6	-3.09	-7.76**	25.94**	-7.23**	-13.17**	25.73**	18.21**	10.61**	39.30**
P3 x P7	9.63**	-0.86	29.11**	5.48**	-1.37*	30.21**	9.47**	-1.25	10.03**
P3 x P8	0.83	-8.80**	21.82**	-1.35	-10.27**	23.87**	-12.79**	-22.54**	-11.57
P3 x P9	-7.00**	[illegible]	14.10**	-7.45**	-13.59**	12.92**	-15.17**	-21.83**	-0.54
P4 x P5	-17.80**	[illegible]	-12.01**	-19.93**	-24.16**	-14.28**	-19.27**	-21.01**	-5.89**
P4 x P6	-17.84**	[illegible]	-1.78	-21.24**	-23.15**	-5.69**	-21.65**	-24.18**	-3.64**
P4 x P7	-21.48**	-22.96**	4.34*	-21.92**	-23.32**	7.62**	-28.26**	-28.75**	10.53**
P4 x P8	-14.01**	-15.65**	4.39*	-15.36**	-15.90**	6.56**	-11.18**	-13.28**	-8.14**
P4 x P9	-3.69*	-5.32*	24.53**	-3.46**	-5.56**	28.49**	-16.48**	-17.86**	-13.07**
P5 x P6	-3.88*	-4.07	24.57**	-8.32**	-11.08**	23.64**	1.56*	0.44	27.69**
P5 x P7	-19.17**	-23.54**	1.05	-21.06**	-23.91**	-3.60**	-31.19**	-33.13**	-17.15**
P5 x P8	-11.61**	-16.39**	9.48**	-14.55**	-19.55**	3.89**	-0.84	-5.23**	11.91**
P5 x P9	-16.09**	-17.79**	-2.66	-16.87**	-19.57**	-5.49**	-24.92**	-25.32**	-31.58**
P6 x P7	-10.33**	-15.02**	19.28**	-8.00**	-8.60**	20.14**	-17.23**	-20.41**	4.20**
P6 x P8	-1.44	-6.61**	22.89**	1.03	-2.02**	26.28**	-3.62**	-8.85**	18.54**
P6 x P9	1.99	0.11	13.14**	-1.11	-1.37	15.24**	3.44**	1.75*	19.09**
P7 x P8	-14.39**	-14.39**	5.60**	-10.25**	-12.42**	5.32**	-25.28**	-26.56**	9.04**
P7 x P9	0.28	-3.23	18.72**	2.68**	[illegible]	20.98**	-19.18**	-21.04**	-20.02**
P8 x P9	-2.63	-6.06**	20.25**	-3.89**	-6.57**	17.94**	0.31	-3.62**	12.74**
LSD 5%	3.64	4.21	3.42	1.38	1.59	1.29	1.39	1.60	1.38
LSD 1%	4.91	5.67	4.73	1.86	2.14	1.79	1.87	2.16	1.80

Table 4. Cont.

Crosses	Boll weight (g)			Seed index (g)			Lint index (g)		
	M.P.	B.P.	I.D.	M.P.	B.P.	I.D.	M.P.	B.P.	I.D.
P1 x P2	3.95**	0.39**	7.14**	-3.54**	-5.22**	0.30	2.92**	-0.36	10.38**
P1 x P3	8.14**	5.64**	19.49**	2.91**	-1.31**	-0.05	0.74**	-3.21**	-0.84**
P1 x P4	12.63**	12.16**	18.71**	4.09**	0.00	-1.33**	-2.85**	-5.56**	-1.73**
P1 x P5	14.35**	12.39**	20.77**	5.32**	0.49	4.94**	0.34	-5.32**	-1.25**
P1 x P6	14.07**	10.24**	20.79**	6.21**	2.29**	3.85**	8.72**	7.68**	9.61**
P1 x P7	-1.79**	-6.45**	12.42**	2.14**	-2.13**	-3.17**	4.63**	-3.93**	5.67**
P1 x P8	7.54**	7.31**	14.29**	-3.95**	-8.36**	0.91**	-8.12**	-12.71**	-9.26**
P1 x P9	13.56**	12.83**	16.31**	-4.58**	-6.07**	2.25**	-5.04**	-6.23**	5.13**
P2 x P3	5.67**	4.45**	12.95**	-0.84**	-6.49**	6.59**	0.84**	0.06	4.46**
P2 x P4	10.98**	7.64**	19.07**	-0.34	-5.85**	6.35**	8.04**	7.59**	14.12**
P2 x P5	1.65**	-0.13**	7.78**	-3.04**	-9.02**	6.05**	3.98**	1.26**	10.25**
P2 x P6	12.16**	12.08**	19.39**	-4.43**	-9.49**	3.37**	-3.72**	-5.92**	7.38**
P2 x P7	7.59**	6.06**	15.87**	-0.92**	-6.64**	5.39**	11.51**	5.56**	4.22**
P2 x P8	17.26**	13.48**	27.24**	-4.72**	-10.6**	2.12**	11.88**	9.73**	20.6**
P2 x P9	5.49**	1.26**	14.93**	-9.24**	-12.18**	2.38**	-0.19	-2.17**	9.61**
P3 x P4	5.54**	3.53**	14.57**	-0.18	-0.36	3.16**	-0.91**	-2.08**	4.22**
P3 x P5	4.51**	3.87**	16.27**	8.07**	7.50**	10.16**	10.34**	8.28**	9.01**
P3 x P6	-2.37**	-3.46**	13.22**	-1.87**	-2.30**	2.17**	-7.92**	-10.71**	1.35**
P3 x P7	-3.81**	-6.26**	13.84**	5.09**	5.00**	5.45**	-1.17**	-5.75**	7.73**
P3 x P8	-3.54**	-5.57**	8.21**	1.62**	1.07**	1.96**	-1.81**	-2.96**	5.69**
P3 x P9	14.01**	10.67**	22.32**	6.17**	3.38**	10.65**	5.68**	2.79**	8.96**
P4 x P5	3.07**	1.72**	6.09**	0.72**	0.00	2.14**	-3.67**	-6.57**	-0.62**
P4 x P6	3.73**	0.66**	15.87**	1.86**	1.59**	5.75**	-4.37**	-6.17**	0.39
P4 x P7	1.59**	-2.84**	17.73**	-1.87**	-2.14**	0.49	-2.89**	-8.43**	5.25**
P4 x P8	4.25**	4.03**	19.76**	-0.36	-1.07**	0.54	-3.20**	-5.45**	3.56**
P4 x P9	4.64**	3.53**	18.85**	-3.21**	-5.58**	2.31**	-2.81**	-4.35**	9.92**
P5 x P6	-1.72**	-3.39**	15.08**	-0.63*	-1.59**	0.97**	-7.52**	-11.94**	-0.52*
P5 x P7	-5.29**	-8.26**	13.71**	2.87**	2.33**	5.09**	-0.98**	-3.82**	-1.28**
P5 x P8	-1.12**	-2.62**	12.31**	-0.54*	-0.54	2.01**	-6.08**	-6.76**	-7.14**
P5 x P9	4.02**	1.58**	17.89**	-4.63**	-7.61**	-1.09**	-6.27**	-10.49**	-5.30**
P6 x P7	-1.96**	-3.42**	16.03**	-1.78**	-2.30**	0.92**	1.53**	-5.96**	2.17**
P6 x P8	7.17**	3.78**	23.08**	-1.16**	-2.12**	0.59	2.30**	-1.91**	7.26**
P6 x P9	1.14**	-2.86**	15.4**	-5.71**	-7.78**	0.61*	-9.71**	-9.99**	4.42**
P7 x P8	6.05**	1.23**	20.84**	-1.17**	-1.61**	0.38	5.84**	2.08**	-0.19
P7 x P9	8.35**	2.58**	22.26**	-4.35**	-6.94**	0.87**	-1.30**	-8.32**	4.67**
P8 x P9	1.57**	0.71**	11.42**	-0.43	-3.55**	5.42**	-2.59**	-6.33**	1.49**
LSD 5%	0.009	0.110	1.370	0.52	0.60	0.60	0.43	0.50	0.40
LSD 1%	0.130	0.150	1.900	0.70	0.81	0.79	0.58	0.67	0.56

Data presented in (Table 5) Showed that the mean performance value of the old variety Ashmouni (P_1) was significantly higher than the most parental means at combined data, while the new variety Giza 88 (P_7) showed significantly lowest values at the combined data .

Generally mean performance values of F_1 hybrids were greater than those of their respective parents indicating the presence of heterotic effect (Table 4). These crosses involved mostly considered as good general combiners. Moreover, the obtained values for F_2 generation were lower than their corresponding values in F_1 indicating that heterotic effect in F_1 was followed by inbreeding depression in F_2 (Table 5) .

3- COBINING ABILITY EFFECTS

The Egyptian cotton genotypes Ashmouni, Dandara, Giza 45, Giza 70 and Giza 88 genotypes exhibited significant positive general combining ability effects with regard to seed cotton yield and most of its contributing variables. On the other hand, Giza 83 variety is almost similar to Giza 86 in their desirable GCA effects on number of bolls per plant, yet Giza 86 was in addition, characterized by desirable GCA effects on boll weight. Further, Giza 80 is regarded as a good general combiner for seed and lint cotton yields. The results concerning general and specific combining ability effects showed significant mean squares for cotton yields in both generations. The combined analysis reflected in some hybrids positive significant SCA effects, while, negative significant SCA effects were exhibited in other hybrids. Similar results were drawn by El-Debaby *et al.* (1997), Pavasia *et al.* (1997), El-Adl *et al.* (2001) and Mosalem *et al.* (2003).

The interaction effects of GCA and SCA with environments were highly significant in all studied yield and yield component traits, indicating that both additive and non-additive gene action tended to interact equally with environments. In this respect, selection for these traits would not be effective in a single environment and hence more environments would be required. However, genotypes mean square value were highly significant for the studied seed cotton yield per plant and its components in the combined analysis, revealing that the performance of genotypes differ from one environment to another. However, the mean square values associated with parents (P) and parents x environments (PxE) were highly significant and/or significant for these characters, revealing that the parental genotypes varied in their response to environment (Table 1). The present results are in general agreement with those obtained by Meredith (1990) and Awaad and Nassar (2001).

Table 5. Mean performance of parental genotypes and their cross combinations in F_1 and F_2 generations in combined data of two environments for seed cotton yield and its components.

Parents	Seed cotton yield (g) / plant		Lint yield (g) / plant		Number of bolls / plant		Boll weight (g)		Seed index (g)		Lint index (g)	
P1	36.18		12.68		15.70		2.34		10.17		5.51	
P2	35.41		11.63		13.70		2.51		10.53		5.16	
P3	31.22		10.99		12.87		2.45		9.33		5.08	
P4	37.12		13.25		15.78		2.36		9.37		5.20	
P5	34.42		11.85		15.10		2.42		9.23		4.89	
P6	34.55		12.60		14.77		2.51		9.42		5.40	
P7	38.59		12.77		16.00		2.58		9.32		4.61	
P8	38.59		13.42		16.57		2.35		9.23		4.96	
P9	35.88		12.67		15.27		2.31		9.85		5.37	
Hybrids	F_1	F_2	F_1	F_2	F_1	F_2	F_1	F_2	F_1	F_2	F_1	F_2
P1 x P2	32.57	34.64	10.62	11.44	11.33	12.50	2.20	2.34	9.83	9.95	4.79	4.92
P1 x P3	26.51	27.84	[illegible]	9.72	12.60	14.00	2.06	2.09	9.80	10.03	5.05	5.37
P1 x P4	27.17	28.21	[illegible]	9.57	12.80	12.40	2.08	2.15	10.30	10.30	5.17	5.29
P1 x P5	27.89	27.25	9.90	9.58	12.70	13.45	2.16	2.16	9.60	9.72	5.30	5.27
P1 x P6	29.81	31.42	10.23	10.96	14.07	12.90	2.13	2.19	10.20	10.00	5.33	5.36
P1 x P7	32.81	34.57	10.55	11.31	14.73	15.33	2.01	2.11	10.13	10.27	4.80	4.99
P1 x P8	26.05	26.86	9.46	9.74	14.07	14.33	1.99	2.16	9.17	9.23	5.23	[illegible]
P1 x P9	22.31	23.37	7.86	8.03	12.27	12.13	2.16	2.21	9.37	9.33	5.10	4.90
P2 x P3	22.10	23.28	7.78	8.11	11.73	11.03	2.13	2.29	9.10	9.20	4.95	4.92
P2 x P4	27.57	28.71	9.35	9.79	12.00	11.47	2.12	2.19	9.30	9.28	4.78	4.80
P2 x P5	23.80	24.75	8.06	8.45	12.73	13.03	2.06	2.31	8.87	9.00	4.58	4.69
P2 x P6	26.27	27.47	8.45	9.28	10.27	11.67	2.14	2.26	9.10	9.22	4.32	4.70
P2 x P7	30.70	31.30	10.83	11.24	14.80	14.60	2.17	2.31	9.27	9.30	5.06	5.21
P2 x P8	26.91	27.73	9.08	9.07	14.93	15.27	2.11	2.07	9.23	9.22	4.71	4.49
P2 x P9	33.04	34.27	11.58	11.80	11.87	14.30	2.19	2.17	8.93	9.03	4.82	4.75
P3 x P4	29.23	30.28	10.39	10.60	12.87	12.70	2.21	2.17	9.00	9.03	4.97	4.88
P3 x P5	25.23	26.08	8.92	9.31	13.13	12.83	2.09	2.13	9.13	9.02	5.00	5.00
P3 x P6	22.71	23.60	8.30	8.13	10.13	9.90	2.06	2.10	8.97	9.00	5.18	4.76
P3 x P7	26.39	27.12	8.80	8.75	13.43	14.22	2.02	2.09	9.30	9.27	4.64	4.42
P3 x P8	27.00	27.51	9.25	9.16	13.37	14.32	2.00	2.13	9.27	9.25	4.86	4.64
P3 x P9	26.00	26.79	9.19	9.53	10.93	12.00	2.04	2.11	9.23	9.10	5.04	5.03
P4 x P5	30.85	32.93	10.35	11.48	15.00	13.20	2.15	2.31	9.30	9.17	4.69	4.89
P4 x P6	29.33	29.96	10.56	10.76	11.40	12.40	2.13	2.12	9.00	9.02	5.06	5.05
P4 x P7	27.03	28.43	9.14	9.39	10.33	10.20	2.01	2.06	9.27	9.12	4.74	4.51
P4 x P8	29.63	31.12	10.37	10.55	13.27	15.53	1.96	1.97	9.23	9.22	4.97	4.74
P4 x P9	25.52	26.52	8.65	8.94	13.53	14.67	2.03	1.98	9.20	9.08	4.73	4.63
P5 x P6	23.83	25.00	8.03	8.56	10.53	10.97	2.05	2.05	9.33	9.18	4.74	4.78
P5 x P7	28.30	29.20	9.90	10.06	12.20	12.53	2.05	2.05	9.03	9.05	4.86	4.76
P5 x P8	28.42	29.21	10.15	10.37	14.13	13.83	2.02	2.06	8.93	9.00	4.96	4.95
P5 x P9	29.40	30.28	9.99	10.75	13.93	15.00	2.00	2.02	9.33	9.20	4.80	5.06
P6 x P7	25.07	26.46	9.03	9.32	12.40	12.20	2.04	2.09	8.93	9.12	5.04	4.97
P6 x P8	26.30	27.79	8.87	9.69	11.73	12.30	2.02	2.00	9.00	9.17	4.62	4.92
P6 x P9	30.20	31.20	10.34	10.59	11.07	12.57	2.08	2.06	8.93	9.03	4.65	4.65
P7 x P8	30.53	31.19	11.32	11.13	10.67	11.07	2.11	2.07	9.03	9.13	5.32	5.07
P7 x P9	29.81	30.35	10.27	10.32	15.60	15.17	2.01	2.06	8.97	9.08	4.72	4.69
P8 x P9	27.64	28.91	9.81	10.28	15.80	13.93	2.01	2.09	9.07	8.98	4.97	4.96
LSD 5%	3.43	3.65	1.24	1.32	1.69	1.51	0.09	0.11	0.51	0.48	n.s.	0.45
LSD 1%	4.62	4.92	1.67	1.77	2.27	2.03	0.13	0.15	0.61	0.65	--	0.61

CONCLUSION

The tested genotypes involved in the study differed markedly with regard to the significance of their combining ability effects, as combiners on the studied characters. These differences do not depend on whether the variety is an old ones (Ashmony, Dandara and Giza 45) or relatively new (Giza 70 , Giza 80 and Giza 83) or newly released once (Giza 85 , Giza 86 and Giza 88). The varietal parents which proved to have desirable GCA effects, do not necessarily produce hybrids of desirable SCA effects. Each studied variety still has its own potentiality as donor of good specific character or characters which could be transferred to new promising hybrid.

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متوسط السلوك والقدرة على الائتلاف وقوة الهجين لأصناف القطن المصرية عند استخدامها كتراكيب وراثية أبوية فى برامج التربية

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يهدف البحث الى تقييم بعض أصناف القطن الحديثة عند استخدامها كآباء تدخل فى برامج التهجين بغرض إنتاج أصناف متفوقة فى المحصول من خلال تقدير بعض الثوابت الوراثية الهامة والمتمثلة فى تقدير القدرة العامة والخاصة على الائتلاف بجانب تقدير قوة الهجين والانخفاض الراجع الى التربية الداخلية .

استخدمت فى الدراسة تسعة أصناف من القطن المصرى الحديثة بجانب الأصناف القديمة للمقارنة – تم الحصول على الهجن الممكنة بين هذه الأصناف (تهجين دائرى) ما عدا الهجن العكسية – تم إجراء تربية ذاتية لنباتات الجيل الأول لإنتاج الجيل الثانى – تم إجراء تقييم لـ ٨١ تركيبة وراثية فى ميعادين للزراعة (بيئتين زراعيتين) بمحطة التجارب الزراعية التابعة لكلية الزراعة بالفيوم – تمت الدراسة فى مواسم ١٩٩٩ ، ٢٠٠٠ ، ٢٠٠١ الصيفية. وكانت أهم النتائج المتحصل عليها :

أظهرت نتائج تحليل التباين وجود اختلافات معنوية بين التراكيب الوراثية (الآباء والهجن الناتجة) لجميع صفات المحصول ومكوناته فى كل من البيئتين والتحليل التجميعى.

كانت قيم معاملات الارتباط عالية المعنوية وموجبة بين متوسط سلوك الآباء والقدرة العامة الائتلافية ويدل ذلك على إمكانية الاعتماد على كل منهما أو أحدهما فى انتخاب أفضل الآباء فى برامج التربية .

كان متوسط سلوك الهجن فى الجيل الأول أكبر من الآباء بالنسبة لمعظم الصفات المدروسة بينما كانت للهجن فى الجيل الثانى أقل بصفة عامة فى أدائها بالمقارنة بالتراكيب الوراثية فى الجيل الأول ، كذلك أظهرت النتائج ظهور قوة الهجين بصفة أساسية عند تقديرها من متوسط الآباء لجميع الصفات فى كل من البيئتين وكذلك التحليل التجميعى – أما قوة الهجين عند تقديرها بالنسبة لأفضل الآباء (أعلى الآباء) كانت ملحوظة فى عدد محدود من هجن الجيل الأول .

تشير النتائج إلى وجود انخفاض معنوى راجع للتربية الداخلية فى الجيل الثانى فى أغلب الحالات المدروسة لمعظم الصفات ومرتبطة بقوة الهجين فى الجيل الأول.

أظهرت النتائج على أن القيم المحسوبة للقدرة العامة على الائتلاف كانت عالية المعنوية لجميع الصفات موضع الدراسة وكانت أكبر من مثيلتها المحسوبة للقدرة الخاصة على الائتلاف فى الهجن لمعظم الصفات

أظهر التحليل التجميعي وجود معنوية عالية لتفاعلات القدرة العامة والقدرة الخاصة مع البيئات لجميع الصفات والذى يدل على اختلاف الأداء الإنتاجي للتراكيب الوراثية باختلاف البيئات .

أظهرت النتائج المتحصل عليها أن انتخاب الآباء على أساس القدرة العامة على الائتلاف يمكن أن يكون مؤشر إيجابي للتنبؤ بالهجن المتفوقة بين هذه الآباء – أى أن المقدرة التربوية الكامنة للآباء يمكن التنبؤ بها من خلال تقديرات القدرة على الائتلاف، بينما أظهرت النتائج أنه لا يوجد صنف متفوق لجميع الصفات ولكن بصفة عامة كانت الأصناف أشمونى – دندرة – جيزة ٤٥– جيزة ٨٨ – جيزة ٧٠ –جيزة ٨٣ –جيزة ٨٥ أفضل الأصناف بالنسبة لصفات المحصول ومكوناته.